MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

PME0016 MECHANICS

(Foundation in Engineering)

11 MARCH 2020
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages, including the cover page.
2. Answer all questions.
3. Write your answers in the Answer Booklet provided.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) An object is acted upon by only two forces that are of equal magnitude and oppositely directed. Is the object necessarily in static equilibrium? Explain why it is or is not.

[2 marks]

b) A child of mass m = 55.0 kg sits on the left end of a seesaw—a plank of length L = 4.00 m, pivoted in the middle as in Figure Q1(a).

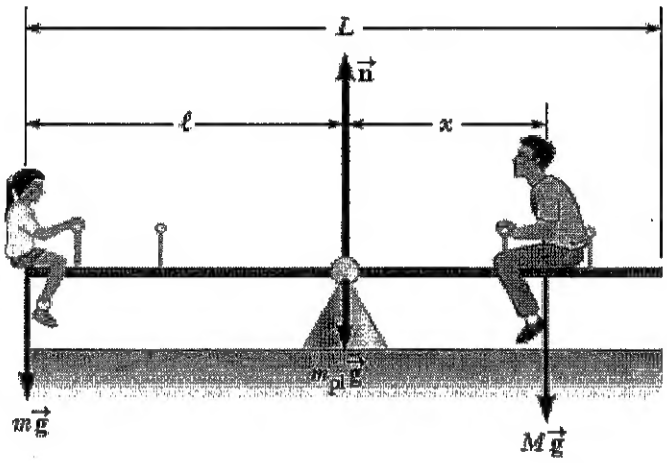

Figure Q1(a)

(i) Where should the man of mass m = 75 kg sit if the system (seesaw together with the child and the man) is to be balanced about an axis at the pivot point?

[2 marks]

(ii) Find the normal force exerted by the pivot if the plank has a mass of m = 12 kg.

[2 marks]

(iii) Repeat part (i), but this time the axis is at the left end of the plank.

[2.5 marks]

(iv) What happens to the torque due to the child's weight about the axis at the pivot point if the child now leans backwards? Explain.

[1.5 marks]

Continued...

QUESTION 2 (10 MARKS)

a) State the principle of conservation of energy.

[1 mark]

b) As shown in Figure Q2(b), a 90-N block at a height of 7 m slides down from rest. Surface AB is smooth whereas surface BC is rough. The frictional force along surface BC brings the block to rest at point C.

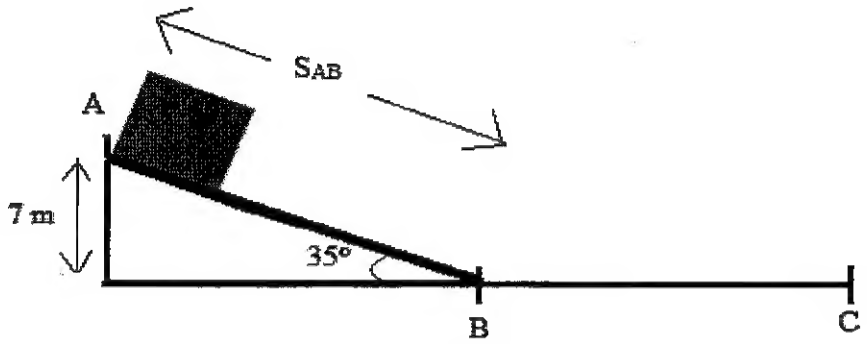

Figure Q2(b)

(i) Calculate the distance S_{AB}.

[1 mark]

(ii) Calculate the net work done on the block along surface AB.

[2 marks]

(iii) Calculate the speed of the block just before it reaches point B.

[3 marks]

(iv) Calculate the energy lost due to frictional force along surface BC.

[3 marks]

QUESTION 3 (10 MARKS)

a) A bicycle odometer (which counts revolutions and is calibrated to report distance traveled) is attached near the wheel hub and is calibrated for 27-inch wheels. What happens if you use it on a bicycle 24-inch wheels? Will the reading of the odometer increase or decrease when we use 24-inch wheels? Explain your answer.

[2.5 marks]

b) A blade of a giant ceiling fan has a radius of 2 m. The blade is rotating with an initial angular velocity of 0.75 rev s^{-1}. The angular acceleration of the blade is 1.50 rev s^{-2}. Determine

(i) the angular velocity after 5s in rad/s,

[2.5 marks]

(ii) the number of revolutions made by the blade in this time interval,

[2 marks]

(iii) the tangential speed of a point on the tip of the blade at time t = 5s,

[1.5 marks]

(iv) the centripetal acceleration of a point on the tip of the blade at time t = 5s.

[1.5 marks]

Continued...

QUESTION 4 (10 MARKS)

a) A metal sphere with a diameter of 4 cm has a density of 7000 kgm^{-3}.

(i) Define apparent weight. Why is apparent weight value smaller than the actual weight?

[2 marks]

(ii) Calculate its apparent weight when it is totally submerged in water. Density of water is 1000 kg/m^3.

[3 marks]

b) A wire 80 cm long and 0.15 m in radius stretches 0.002 m when a load of 5 kg is hung on its end. For the material of the wire, calculate.

(i) the stress,

[2 marks]

(ii) the strain,

[1.5 marks]

(iii) the Young's modulus.

[1.5 marks]

QUESTION 5 (10 MARKS)

An oscillator is made up of a wooden block of mass 0.80 kg that is attached to a spring. The period of oscillation is 0.40 s and it undergoes simple harmonic motion with an amplitude of 0.40 m. Calculate

(i) the frequency,

[1 mark]

(ii) the angular frequency of oscillation,

[1.5 marks]

(iii) the spring constant,

[1.5 marks]

(iv) the maximum velocity,

[1.5 marks]

(v) the potential and kinetic energy of the system at a position of 0.20 m from the equilibrium position,

[3 marks]

(vi) the total energy of the system.

[1.5 marks]

Continued...

APPENDIXES

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 Nm^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

$$\frac{dy}{dx} = knx^{n-1}$$

Trigonometric Identity

$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

NEWTONIAN MECHANICS

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v = u + at \qquad s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as \qquad s = \left(\frac{u+v}{2}\right)t$$

$$W = Fs\cos\theta \qquad W = mg \qquad \sum F = F_{net} = ma$$

$$f = \mu N \qquad p = mv \qquad \sum F = \frac{\Delta p}{\Delta t}$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2 \qquad m_1u_1 + m_2u_2 = (m_1 + m_2)v \qquad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$$

$$K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx \qquad PE_G = mgy$$

$$v_{circular} = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r} \qquad F_g = G\frac{m_1m_2}{r^2} \qquad U_g = -G\frac{m_1m_2}{r}$$

$$T^2 = K_sr^3 \qquad T_s = 2\pi\sqrt{\frac{m}{k}} \qquad F_c = m\frac{v^2}{r}$$

$$\omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{g}{l}} \qquad T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f}$$

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